Supplement

Integrated logic circuit applications Mullard FC range

Mullard

FOREWORD

The Mullard FC range of integrated logic circuits is suitable for use in general industrial applications. The book "Integrated Logic Circuit Applications—Mullard FC Range" (TP854/1) provides an introduction to the theory of logic and contains many examples of practical circuits using the FC range of devices. The present supplement contains several more examples of counter circuits, two output amplifiers and a free running multivibrator.

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COUNTERS

In an asynchronous counter, the trigger input of each bistable circuit is connected to the output of the preceding bistable circuit. This results in a "ripple-through" of the count pulses, so that the last bistable circuit cannot change its state until all the preceding bistable circuits have changed state. The delay inherent in ripple-through counters is avoided in synchronous counters by using the outputs of bistable circuits as gating signals to the count pulses which are fed to all bistable circuits in the counter. In this way, all those stages that are required to change state when a particular count pulse arrives will change simultaneously.

A series of n triggered bistable circuits (such as J-K flip-flops) will count 2^n-1 pulses and then return to its original state after the next pulse. If the full count is required to be a number "m" which cannot be expressed in the form 2^n-1, then additional gating is used to detect when the number m is reached and to reset the counter to zero after the next pulse. In this way, a "modulom+1" counter is constructed, where $m+1$ can be any number.

Counting in codes other than pure binary—for example, a weighted code such as 1242 BCD or a cyclic-progressive code in which only one bit changes at any time—is achieved by gating between stages of the counter. The gating required depends on the code being used and allows each stage to change state only when required by the code.

Counters can count either up or down, that is, they can either add or subtract one for each input pulse. By combining an up and a down counter, with suitable gating, a reversible counter is obtained.

All the counters shown in the following examples use the multi-input J-K flip-flop, type FCJ101. All unused J and K inputs can either be connected to the positive supply line or left open-circuited, but they must not be connected to earth because this would completely inhibit the flip-flop inputs. Each counter has a resetting line (S), as well as a count input line (A), so that the counter can be reset to its initial state at any time. In accordance with the operational requirements of the FCJ101 this resetting line must normally be at "1" and is changed to "0" when resetting is required.

UNWEIGHTED MODULO-11 COUNTER

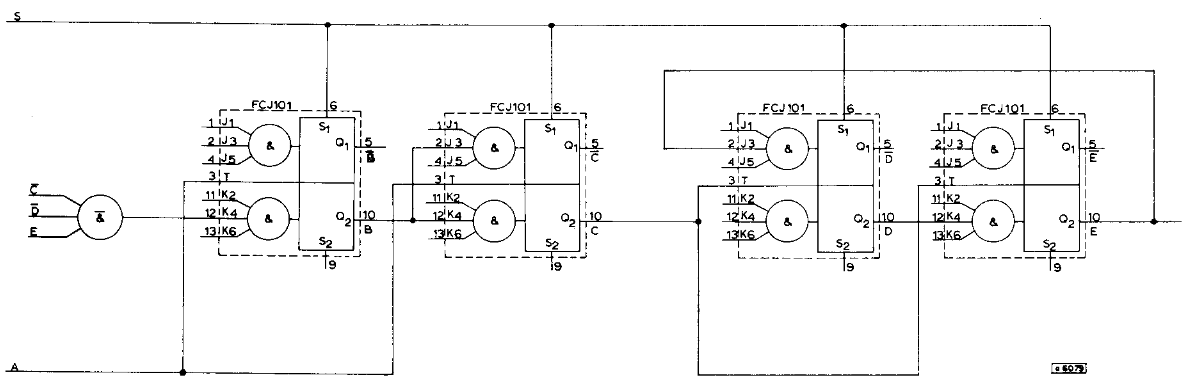

Fig. 1—Unweighted modulo-11 counter

Truth Table

	B	C	D	E
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	0	1
5	1	0	0	1
6	1	1	0	1
7	0	0	1	1
8	1	0	1	1
9	0	1	1	1
10	1	1	1	1
11 (= 0)	0	0	0	0

UNWEIGHTED MODULO-7 COUNTER

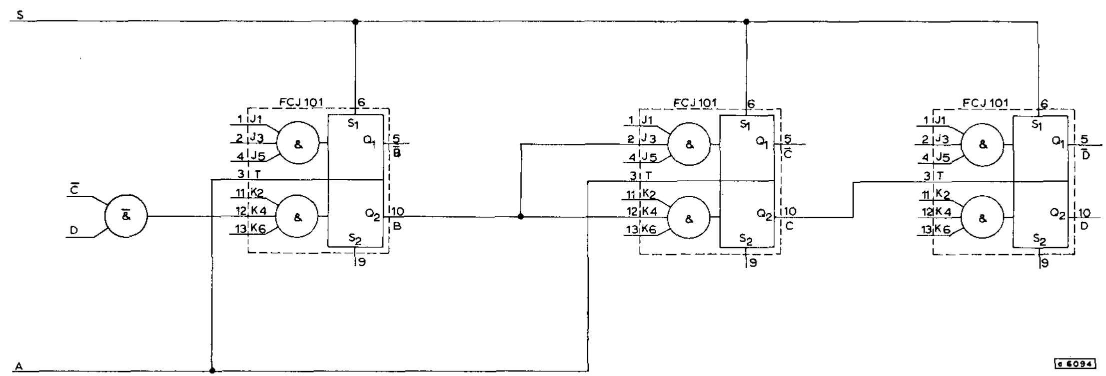

Fig. 2—Unweighted modulo-7 counter

Truth Table

	B	C	D
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	1	1	1
7 (= 0)	0	0	0

SYNCHRONOUS UNWEIGHTED MODULO-5 COUNTER

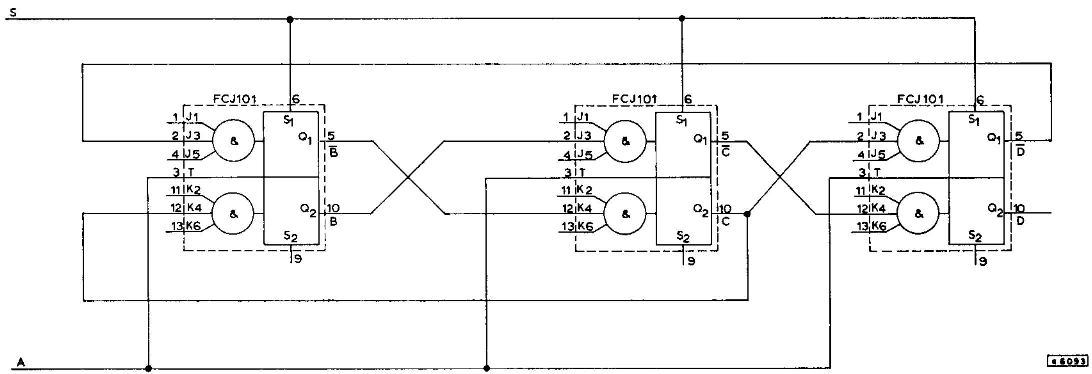

Fig. 3—Synchronous unweighted modulo-5 counter

Truth Table

	B	C	D
0	0	0	0
1	1	0	0
2	1	1	0
3	0	1	1
4	0	0	1
5 (= 0)	0	0	0

SYNCHRONOUS MODULO-3 COUNTER

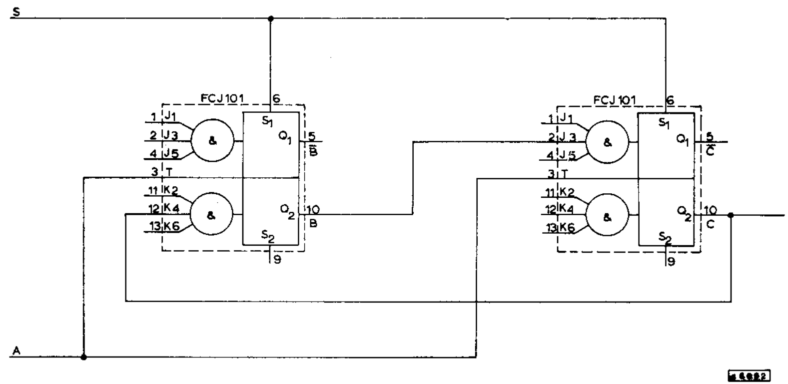

Fig. 4—Synchronous modulo-3 counter

Truth Table

	B	C
Weight =	1	1
0	0	0
1	1	0
2	1	1
3 (= 0)	0	0

ASYNCHRONOUS 1242 BCD (JUMP 3 TO 10) DECADE COUNTERS

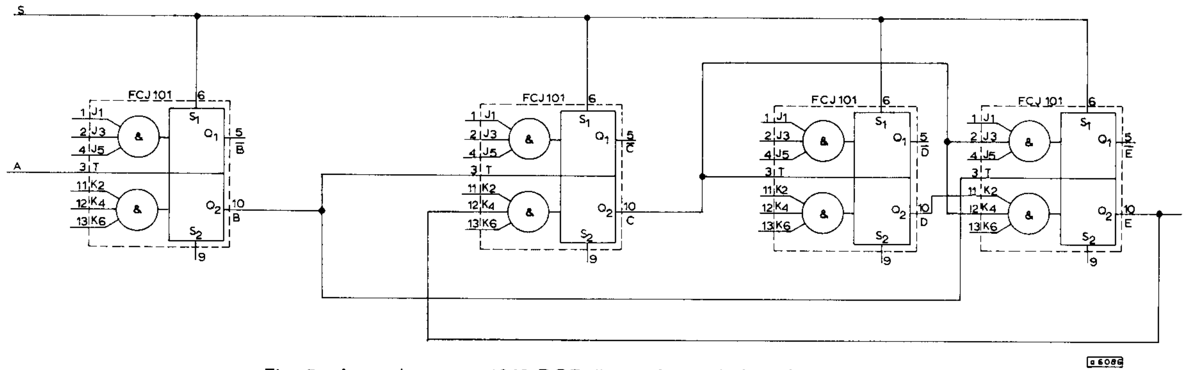

Fig. 5—Asynchronous 1242 BCD (jump 3 to 10) decade up counter

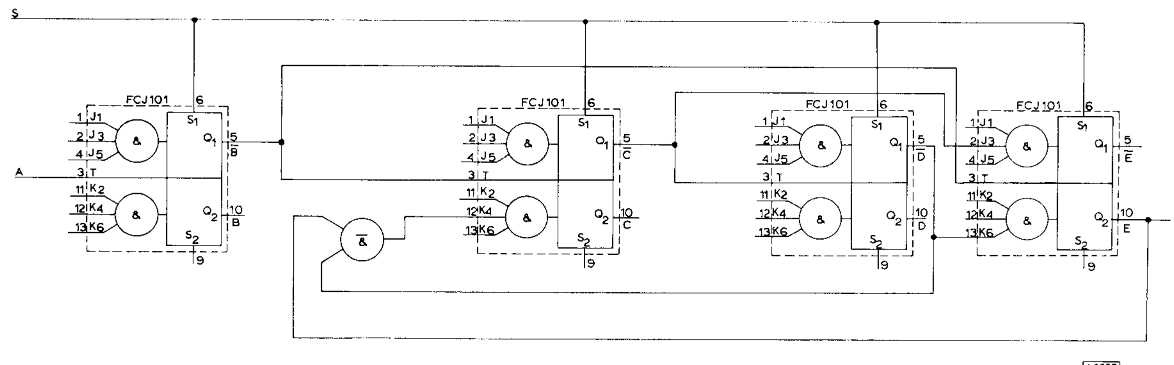

Fig. 6—Asynchronous 1242 BCD (jump 3 to 10) decade down counter

Truth Table

	B	C	D	E
	1	2	4	2
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	0	1
5	1	1	0	1
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1
10 (= 0)	0	0	0	0

ASYNCHRONOUS AIKEN 1242 CODE DECADE COUNTERS

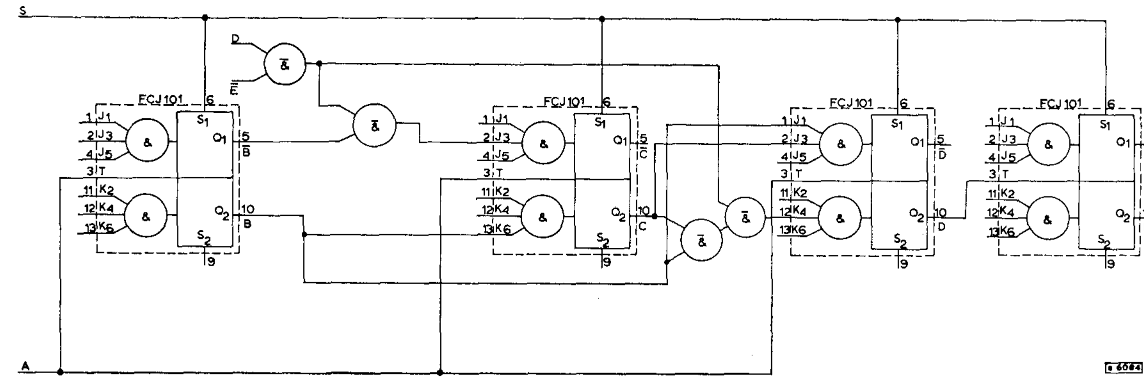

Fig. 7—Asynchronous Aiken 1242 decade up counter

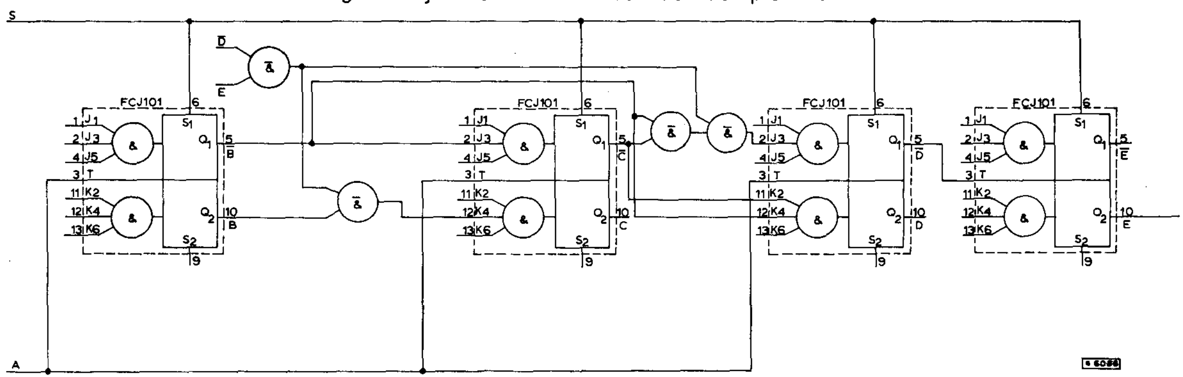

Fig. 8—Asynchronous Aiken 1242 decade down counter

Truth Table

	B	C	D	E
Weight =	1	2	4	2
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	1	0	1
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1
10 (= 0)	0	0	0	0

ASYNCHRONOUS 1242 BCD (JUMP 7 TO 14) DECADE COUNTERS

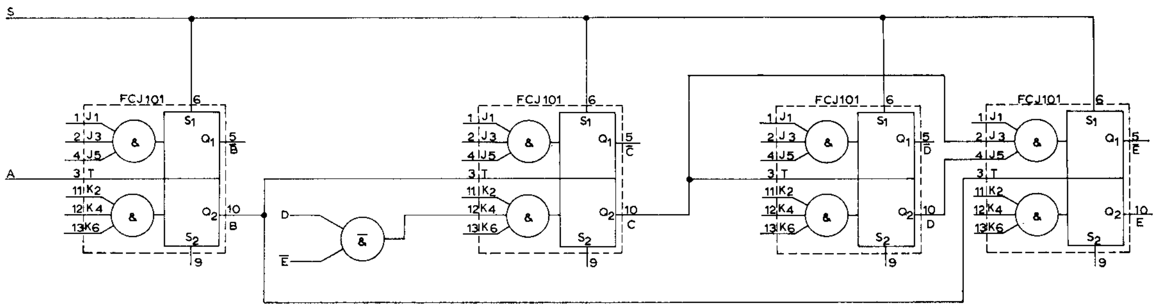

Fig. 9—Asynchronous 1242 BCD (jump 7 to 14) decade up counter

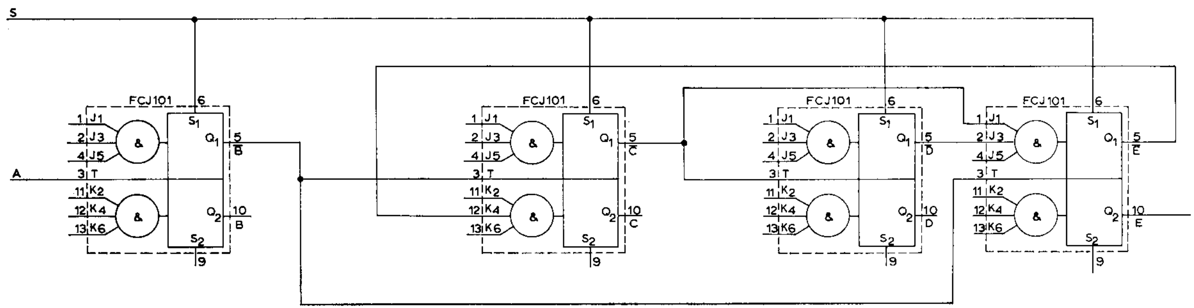

Fig. 10—Asynchronous 1242 BCD (jump 7 to 14) decade down counter

Truth Table

	B	C	D	E
Weight =	1	2	4	2
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	1	1	1
9	1	1	1	1
10 (= 0)	0	0	0	0

ASYNCHRONOUS 1248 BCD DECADE COUNTERS

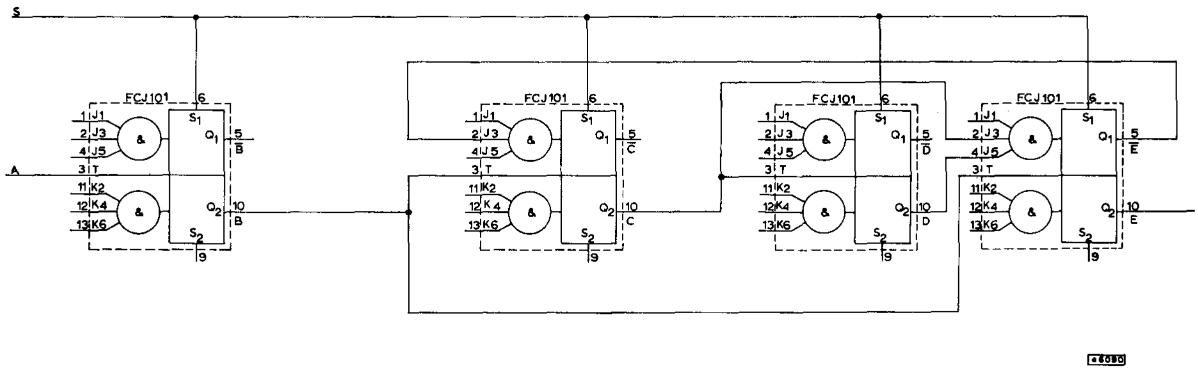

Fig. 11—Asynchronous 1248 BCD decade up counter

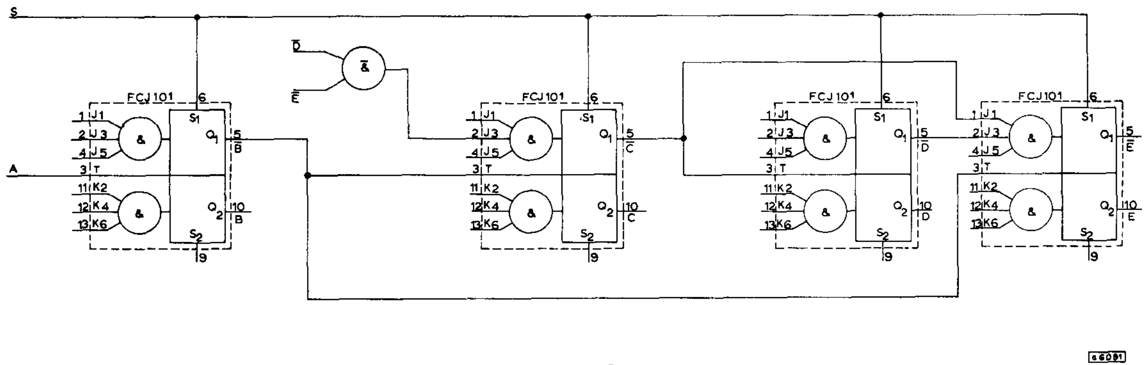

Fig. 12—Asynchronous 1248 BCD decade down counter

Truth Table

	B	C	D	E
Weight =	1	2	4	8
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10 (= 0)	0	0	0	0

ASYNCHRONOUS EXCESS-THREE CODE DECADE COUNTERS

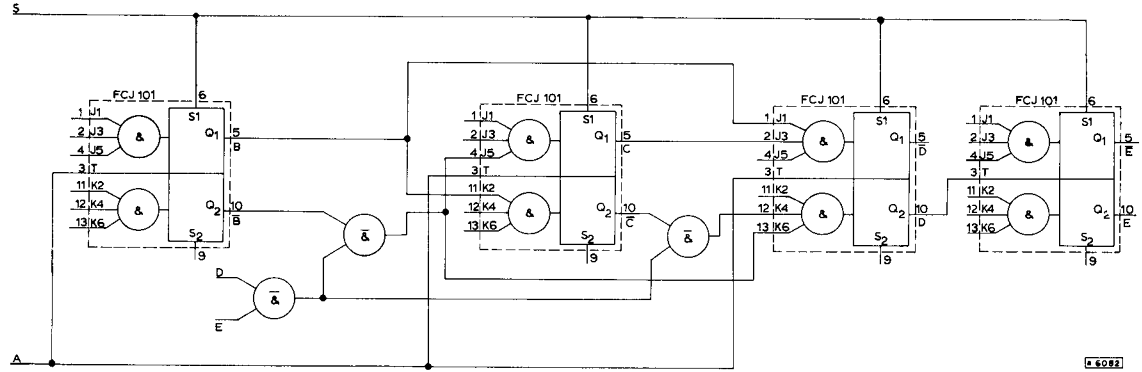

Fig. 13—Asynchronous excess-three code decade up counter

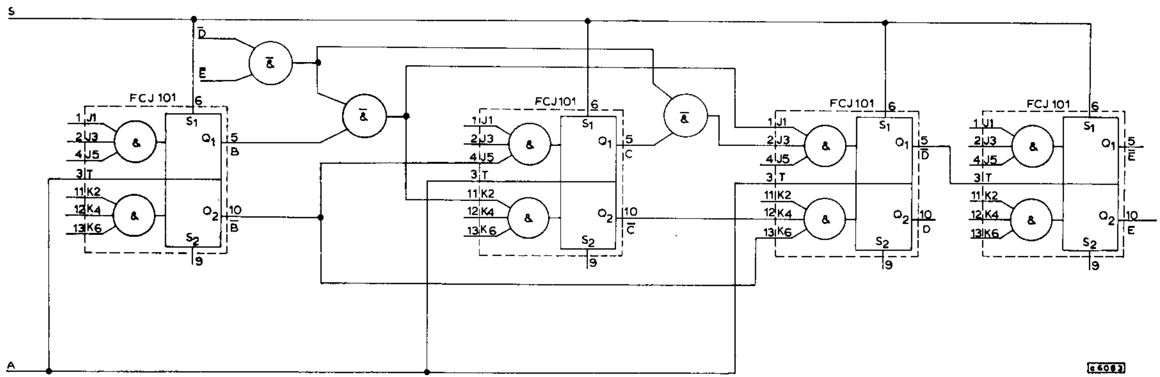

Fig. 14—Asynchronous excess-three code decade down counter

Truth Table

	B	C	D	E
0	1	1	0	0
1	0	0	1	0
2	1	0	1	0
3	0	1	1	0
4	1	1	1	0
5	0	0	0	1
6	1	0	0	1
7	0	1	0	1
8	1	1	0	1
9	0	0	1	1
10 (= 0)	1	1	0	0

SYNCHRONOUS 1242 BCD (JUMP 7 TO 14) DECADE COUNTERS

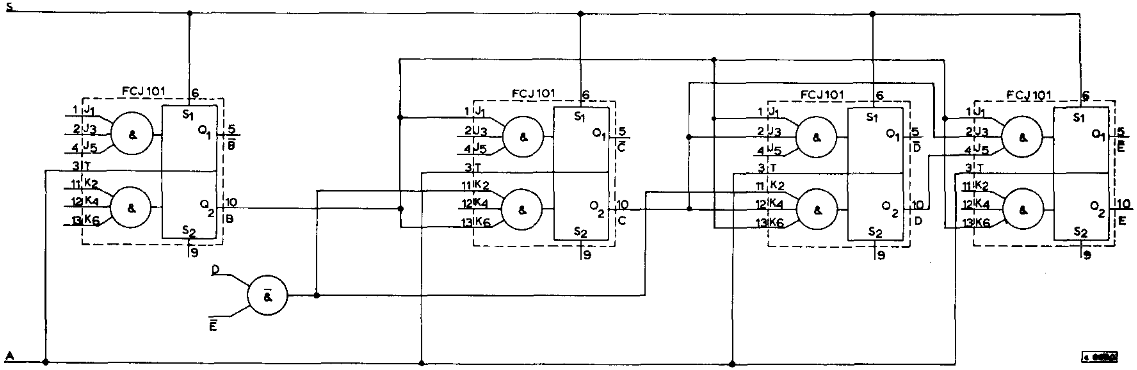

Fig. 15—Synchronous 1242 BCD (jump 7 to 14) decade up counter

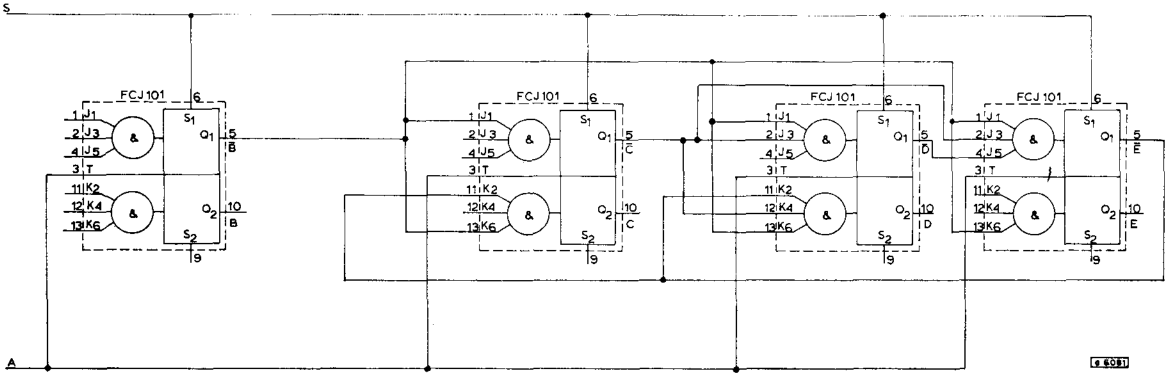

Fig. 16—Synchronous 1242 BCD (jump 7 to 14) decade down counter

Truth Table

Weight =	B 1	C 2	D 4	E 2
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	1	1	1
9	1	1	1	1
10 (= 0)	0	0	0	0

REVERSIBLE SYNCHRONOUS DECADE COUNTER

This is a simplified version of the counter shown in Fig. 55 of "Integrated Logic Circuit Applications—Mullard FC Range"

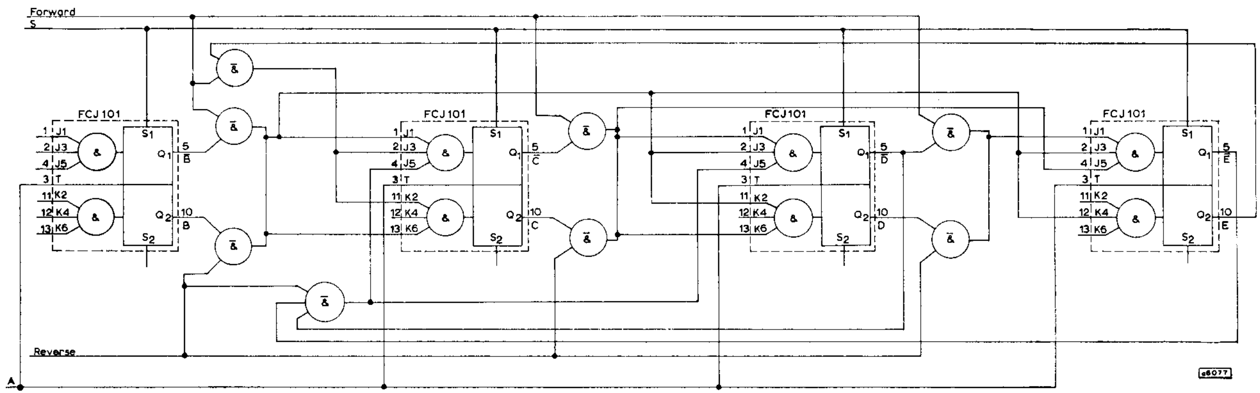

Fig. 17—Reversible synchronous decade counter

Truth Table

	B	C	D	E
Weight =	1	2	4	8
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10 (= 0)	0	0	0	0

OUTPUT AMPLIFIERS

These two amplifiers, constructed from discrete components, are necessary when the normal output of a gate in the FC range is insufficient, as frequently happens when a visual indication is required or when a relay is to be driven.

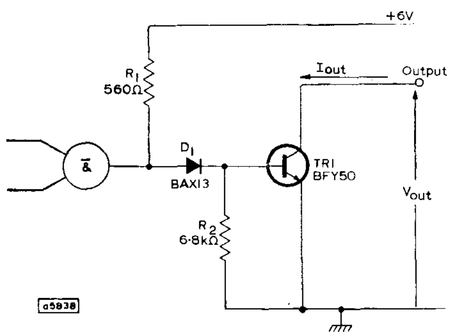

Fig. 18—Output amplifier giving maximum output current of 100mA

Performance

Gate Output	Low	High	
V_{out}	35	0·2	V
I_{out}	0·002	100	mA

If this amplifier is used with an inductive load, a diode should be connected across the load as shown in Fig. 20

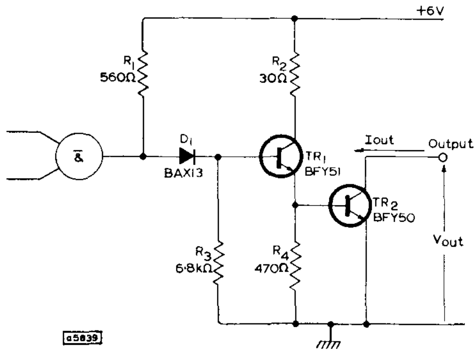

Fig. 19—Output amplifier giving maximum output current of 1A

Performance

Gate Output	Low	High	
V_{out}	35	1·0	V
I_{out}	0·005	1000	mA

If this amplifier is used with an inductive load, a diode should be connected across the load as shown in Fig. 20

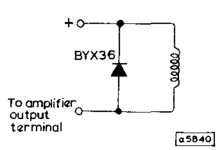

Fig. 20—Diode connected across an inductive load

FREE RUNNING MULTIVIBRATOR

A multivibrator is a square-wave oscillator used for generating a continuous supply of pulses. The operating frequency of the circuit given below is determined by the value of capacitance, C.

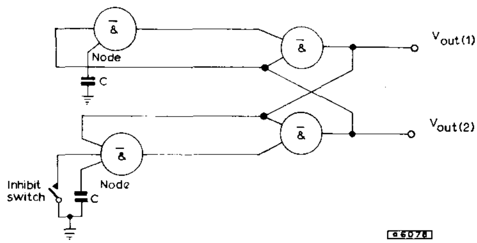

Fig. 21—Free running multivibrator

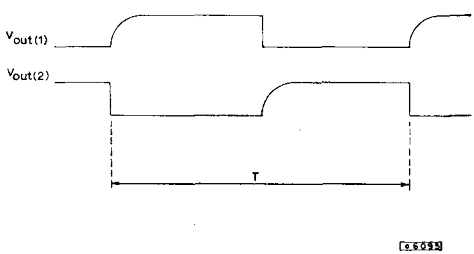

Fig. 22—Waveforms for free running multivibrator

$$T = 2{\cdot}25C \text{ ns} \pm 20\% \text{ when C is in pF}$$

$$\frac{\Delta T}{\Delta V_p} = -20\% \text{ at } \Delta V_p \leqslant 10\%$$

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